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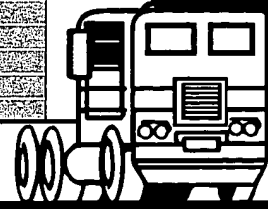
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## M-21 and M-22 Antilock Modulator Assembly

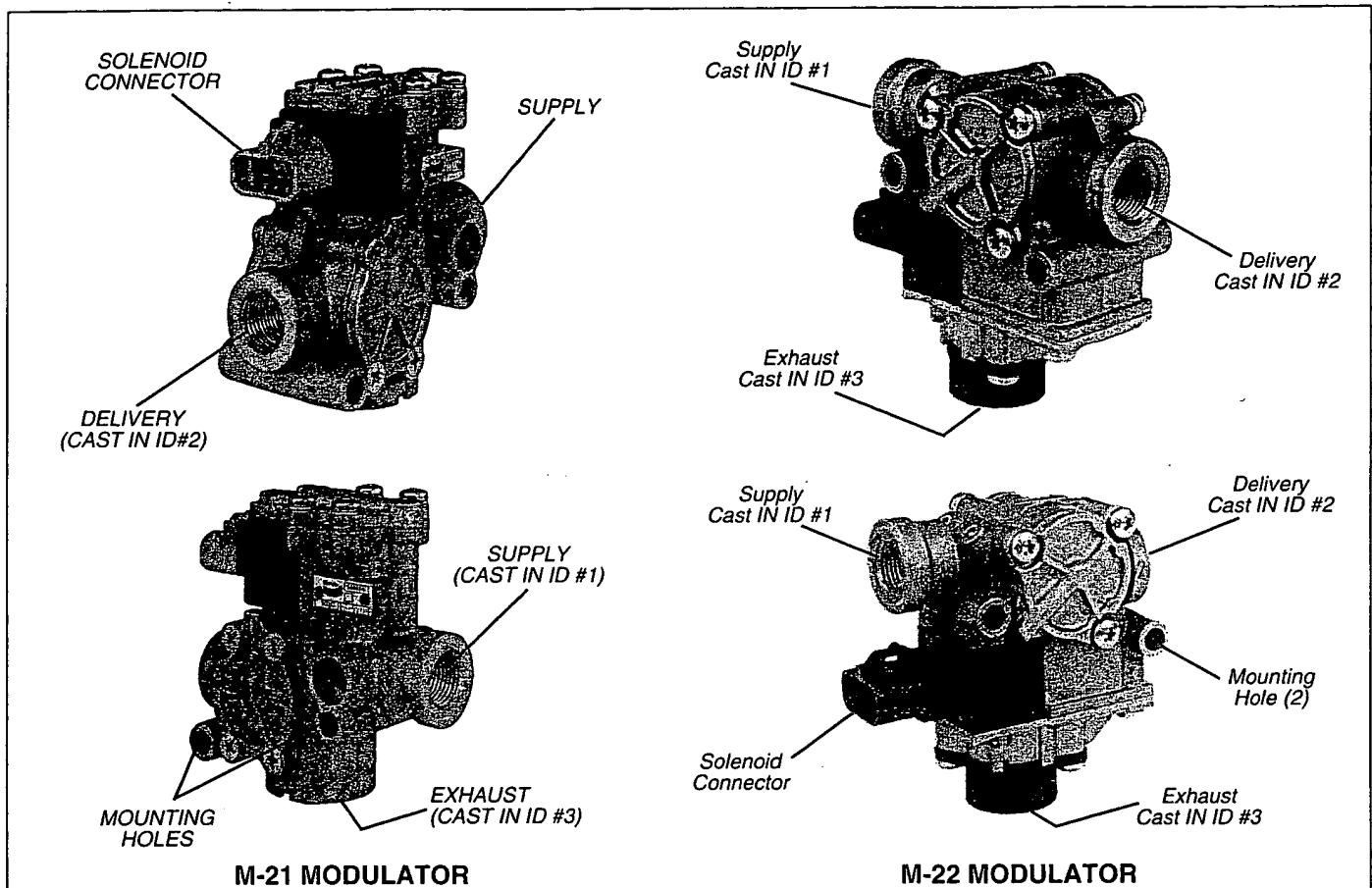


FIGURE 1 M-21 AND M-22 MODULATOR

### DESCRIPTION

There are two Bendix antilock modulators available from AlliedSignal Truck Brake Systems, the older M-21 and the newer M-22. Both are functionally the same.

The M-21 and M-22 antilock system modulators (Figure 1) are essentially high capacity, on/off air valves that incorporate a pair of electrical solenoids for control. The solenoids provide the electro-pneumatic interface or link between the antilock controller electronics and the air brake system. The modulator can be used to control the braking function on an individual wheel or two service actuators. When used to control both service chambers on an axle or two chambers on the same side of a tandem axle, the modulator is sometimes mounted ahead of a quick release valve, which provides quick exhaust of service applications during normal braking. (Figure 2) In the case of indi-

vidual wheel control applications, the modulator is always the last control valve through which air passes on its way to the service brake actuator.

The modulator consists of a die cast aluminum body and a solenoid assembly which contains one normally open solenoid (NOS), one normally closed solenoid (NCS), and two inlet and exhaust diaphragm valves. A Packard, three pin, 280 series weather resistant electrical connector is an integral part of the modulator solenoid assembly and serves to carry control commands from the antilock controller to the modulator. Two, .35 inch diameter, mounting holes are provided for frame or cross member mounting. The single Supply, Delivery and Exhaust port on both modulators is identified with a cast, embossed numeral for positive identification. They are as follows;

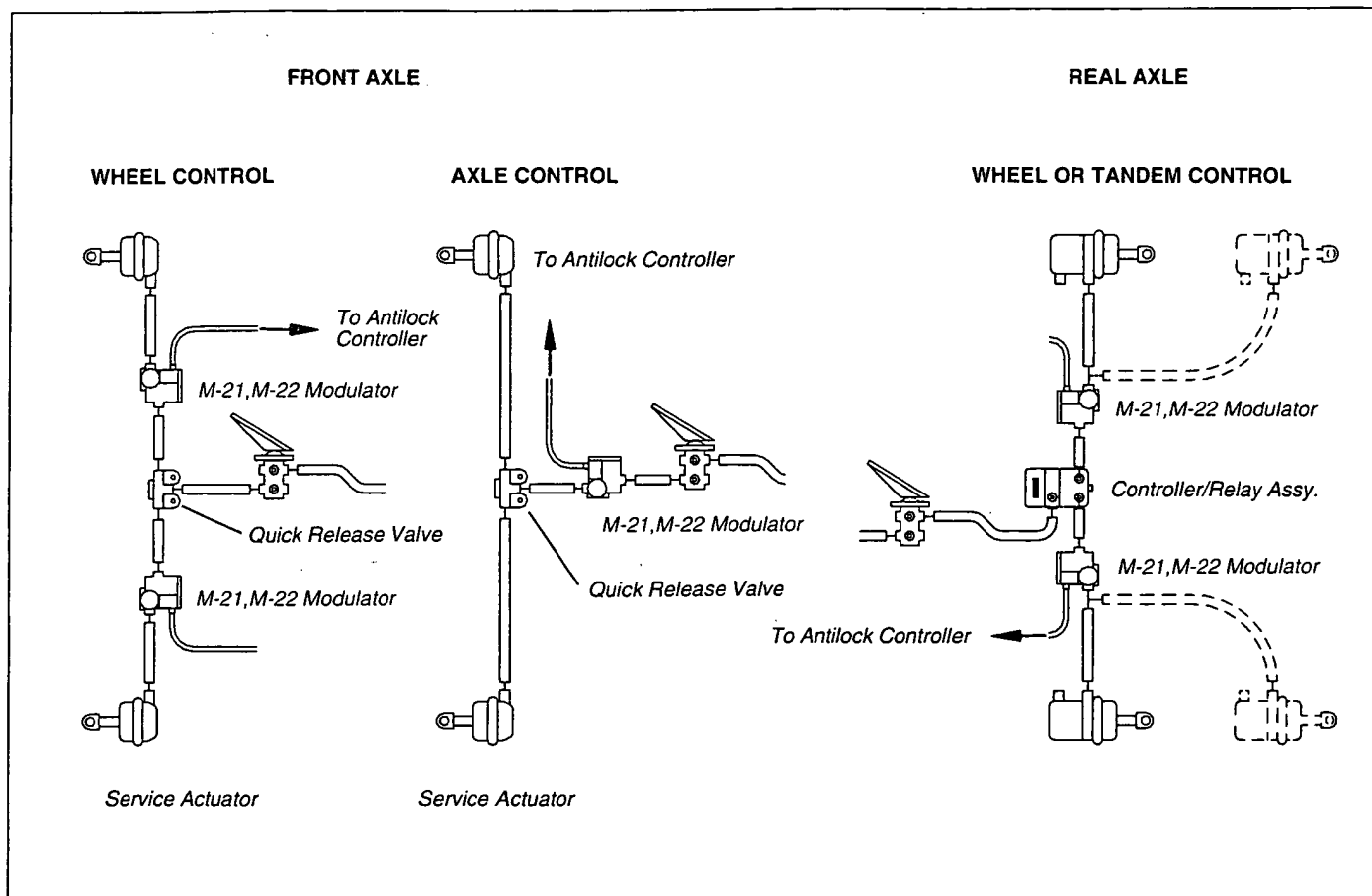


FIGURE 2 SCHEMATIC OF WHEEL AND AXLE CONTROL

Identification	Air Line Connection
1	Supply (incoming air from foot valve or relay)
2	Delivery (air delivery to service actuators)
3	Exhaust (air exhaust during antilock control)

## OPERATION

### NON-ANTILOCK APPLICATION (Figure 3)

During normal non-antilock braking, both solenoids are de-energized (no electrical power). Brake application air enters the Supply port of the modulator and flows to, and through, the open exhaust solenoid then to the exhaust diaphragm. Air pressure, along with spring force, seats the exhaust diaphragm on the exhaust passage thus preventing the escape of service air. Simultaneously, application air flows to the supply diaphragm and forces it away from its seat. Air flows past the open supply and out the modulator delivery port to the service brake chambers.

### NON-ANTILOCK HOLD (Figure 4)

When the desired air pressure is attained in the service brake chambers, the brake system is in the Holding position. In the Holding position both solenoids in the modulator remain de-energized and the balance of the internal components remain in the same position as they assumed during application.

### NON-ANTILOCK EXHAUST

The manner in which air exhausts through the modulator differs, depending upon how rapidly the brake application is released by the driver.

**Normal Exhaust (Figure 5)** - During a normal, relatively "slow", brake release, air moves back through the modulator in the reverse direction as it flowed during application. The internal components of the modulator will remain in the same position as they assumed during application until air pressure decreases to approximately one half psi, at which time the supply diaphragm will seat on the supply passage. Air will generally not be expelled from the modulator exhaust port during normal brake release.

**Rapid Exhaust (Figure 6)** - The Rapid Exhaust operation described in the following text only occurs when the modulator is controlling two type 30 (or larger)

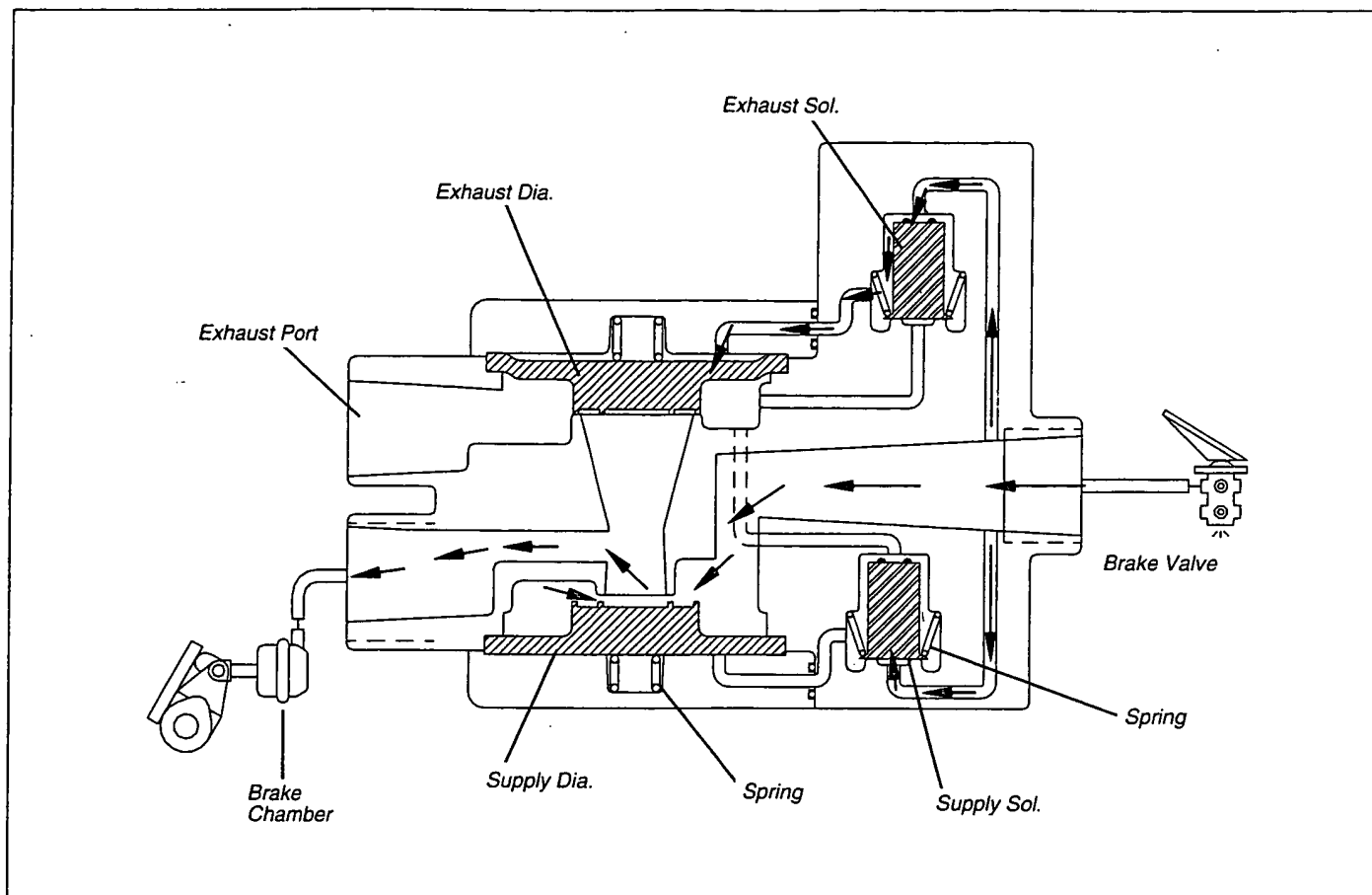


FIGURE 3 M-21,M-22 NON-ANTILOCK APPLICATION OF SERVICE BRAKES

service chambers. During a very rapid brake release the modulator will exhaust air in a different manner. An example of this would be the case if the driver made a severe brake application then lifted his foot from the foot valve. During a rapid brake release, air from the exhaust diaphragm flows back through the open exhaust solenoid and to the application device's exhaust. With pressure removed from the control side of the exhaust diaphragm, air, returning to the modulator from the service chambers, lifts the exhaust diaphragm from its seat. Returning air flows past the open exhaust and out the the modulator exhaust port. Air will also flow past the open supply diaphragm and back to the application device's exhaust.

#### ANTILOCK OPERATION - GENERAL

If a service brake application is made and the antilock system detects an impending wheel lockup, the antilock controller will immediately begin modification of the brake application using the modulator.

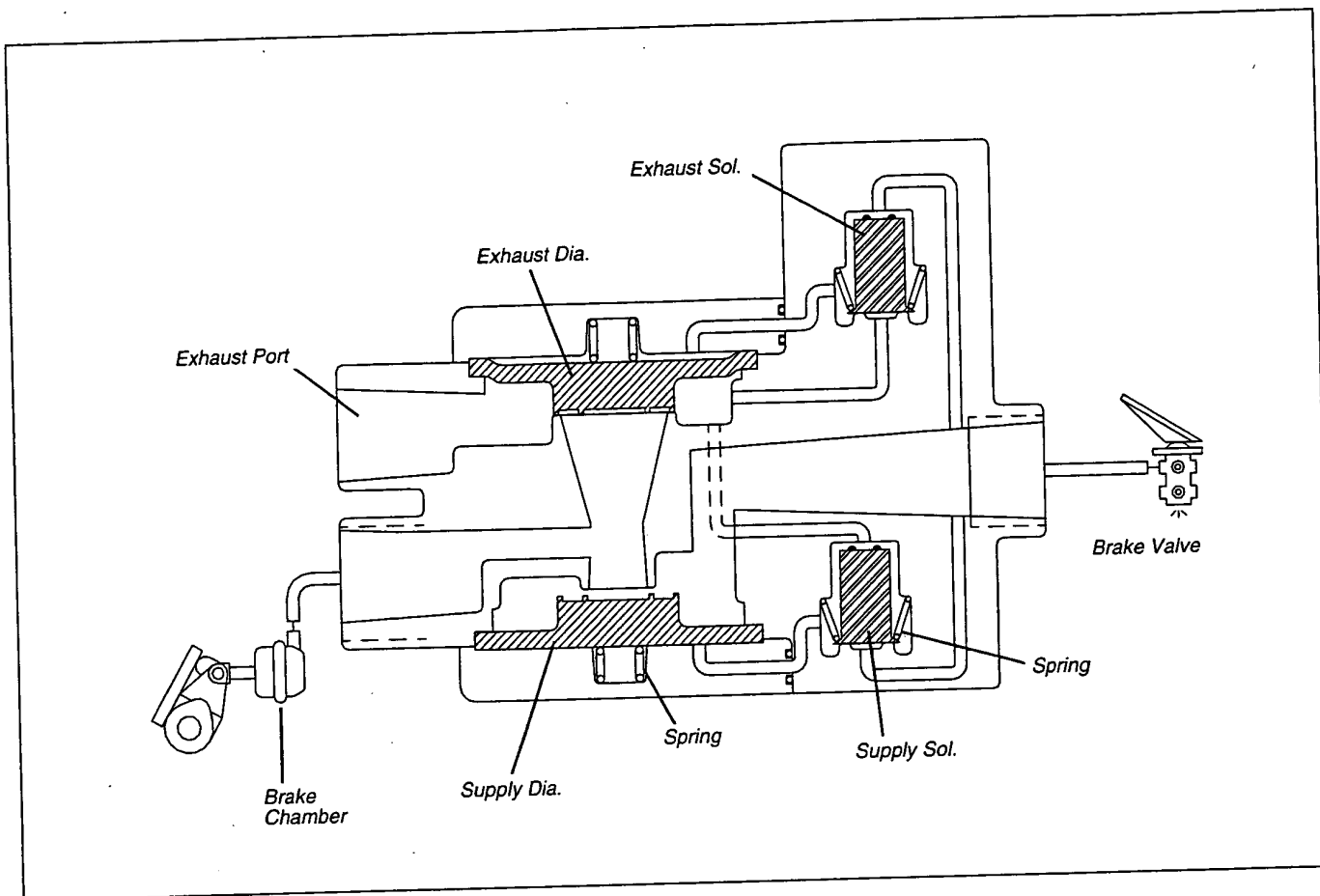
In order to modify the brake application, the coils of the two solenoid valves contained in the modulator are energized or de-energized in a pre-programmed sequence by the antilock controller. When a solenoid coil is energized, a shuttle within the solenoid moves, and depending upon the function of the specific

solenoid, it either opens or closes thereby causing the exhaust or re-application of air pressure to the brake actuator. The solenoids in the modulator are controlled independently by the antilock controller. By opening and closing the solenoid valves in the modulator, the antilock controller is able to simulate what the driver does when he "pumps the brakes". It must be remembered however that unlike the driver the antilock controller is able to "pump" each modulator, along with the brakes connected to it, independently and with far greater speed and accuracy.

#### ANTILOCK EXHAUST (Figure 7)

When wheel lock is detected, or imminent, the antilock controller simultaneously energizes both the supply and exhaust solenoids in the modulator. Energizing the supply solenoid causes its exhaust to close and inlet to open. With the inlet of the supply solenoid open, application air is permitted to flow to the control side of the supply diaphragm. Air pressure acting on the supply diaphragm causes it to close the supply and prevent further delivery of air to the brake chamber.

Energizing the exhaust solenoid closes its inlet and opens its exhaust. By closing the exhaust solenoid inlet, application air is prevented from flowing to the control side of the exhaust diaphragm. Air pressure,



**FIGURE 4 M-21,M-22 NON-ANTILOCK HOLDING POSITION**

which was present on the control side of the exhaust diaphragm flows out the exhaust port of the modulator. With control air pressure removed from the exhaust diaphragm, brake application air forces the exhaust diaphragm to unseat which allows it to flow out the modulator exhaust port. The modulator will remain in the Antilock Exhaust mode until the antilock controller senses that wheel speed has increased. The modulator can enter the Antilock Hold or Re-apply mode from the Antilock Exhaust mode.

### ANTILOCK HOLD

The antilock controller will place the modulator in the Hold position when it senses that the correct wheel speed (braking force) has been attained. The antilock controller will also place the modulator in the Hold position, prior to entering the Re-Apply, when it detects recovery from a locked wheel condition. In this mode of operation the modulator supply solenoid remains energized while the exhaust solenoid is de-energized. De-energizing the exhaust solenoid opens its inlet and closes its exhaust. Opening the exhaust solenoid inlet, allows application air to flow to the control side of the exhaust diaphragm which then seals the exhaust passage. With the exhaust diaphragm seated, further exhaust of brake chamber air pressure is prevented. Because the supply solenoid remains energized the

supply diaphragm remains seated, thus preventing application air from flowing to the delivery port and out to the brake chamber. The modulator can enter the Antilock Exhaust or Re-apply mode from the Antilock Hold mode.

### ANTILOCK RE-APPLY

If the antilock controller senses that wheel speed has increased sufficiently to require re-application of braking pressure, it de-energizes the supply and exhaust solenoids. With both solenoids de-energized, the modulator re-applies air to the brakes in the same manner it did during a Non-Antilock Application.

## PREVENTIVE MAINTENANCE

### GENERAL

Perform the tests and inspections presented at the prescribed intervals. If the modulator fails to function as described, or leakage is excessive, it should be replaced with a new or genuine Bendix remanufactured unit, available at any authorized parts outlet.

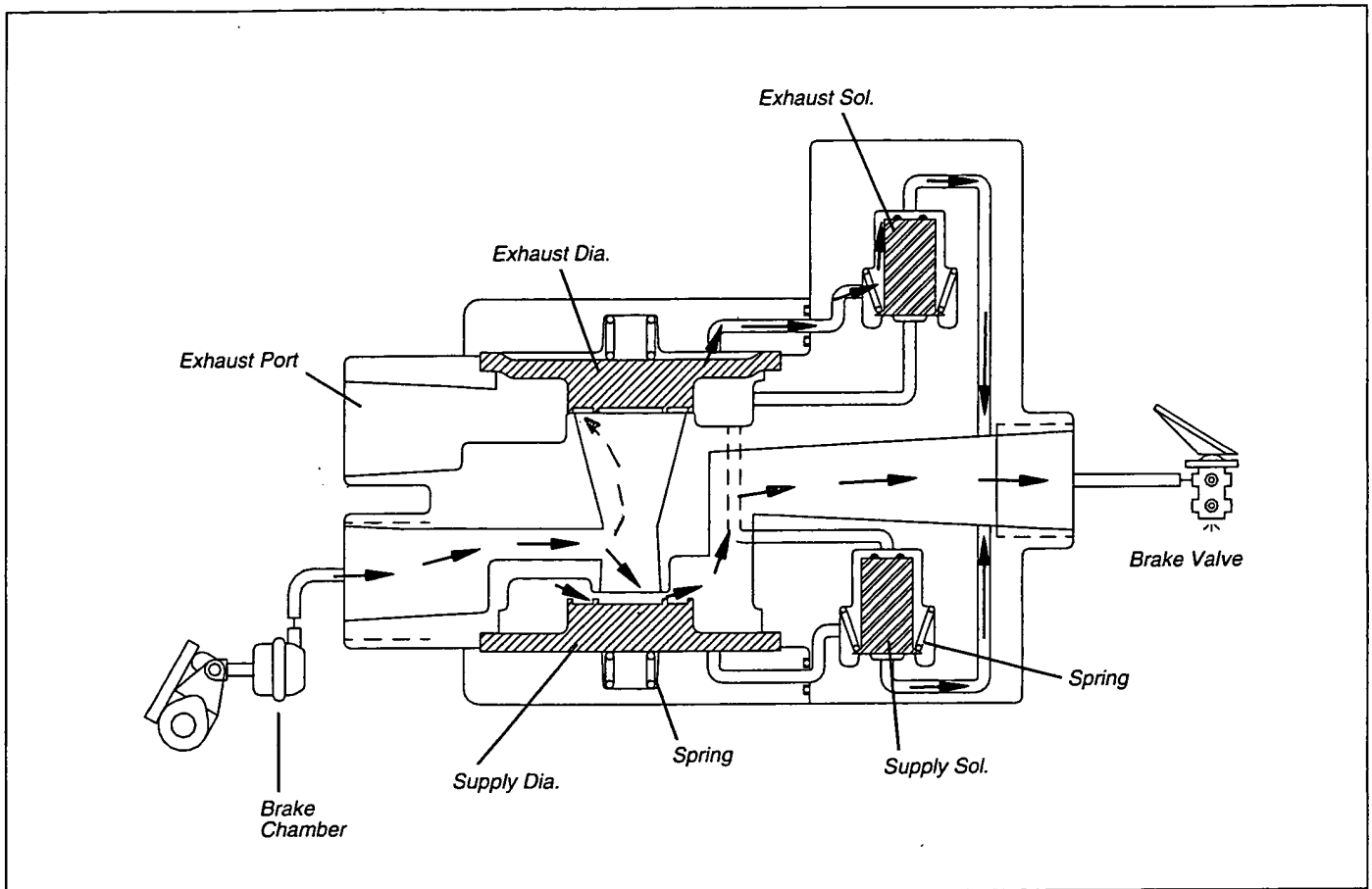


FIGURE 5 M-21,M-22 NON-ANTILOCK EXHAUST (NORMAL)

### EVERY 3 MONTHS, 25,000 MILES OR 900 OPERATING HOURS

1. Remove any accumulated contaminants and visually inspect the exterior for excessive corrosion and physical damage.
2. Inspect all air lines and wire harnesses connected to the modulator for signs of wear or physical damage. Replace as necessary.
3. Test air line fittings for excessive leakage and tighten or replace as necessary.
4. Perform the ROUTINE OPERATION AND LEAKAGE TESTING described in this manual.

## OPERATION & LEAKAGE TESTS

### LEAKAGE TESTING

1. Park the vehicle on a level surface and block or chock the wheels. Release the parking brakes and build the air system to full pressure.
2. Turn the engine OFF and make 4 or 5 brake applications and note that the service brakes apply and release promptly.
3. Build system pressure to governor cut-out and turn the engine OFF.

4. Make and hold a full service brake application.
  - A. Apply a soap solution to the exhaust port of the modulator. Leakage should not exceed a one inch bubble in less than 3 (three) seconds. If leakage exceeds the specified maximum, replace the modulator.
  - B. Apply a soap solution around the solenoid assembly (top and bottom). Leakage should not exceed a one inch bubble in less than 3 (three) seconds. If leakage exceeds the specified maximum, tighten the solenoid cap screws and re-test. If the leakage remains excessive after re-testing, replace the modulator.
  - C. Apply a soap solution around each diaphragm cover. Leakage should not exceed a one inch bubble in less than 3 (three) seconds. If leakage exceeds the specified maximum, tighten the diaphragm cap screws and re-test. If the leakage remains excessive after re-testing, replace the modulator.

### OPERATION TESTING

To properly test the function of the modulator will require 2 service technicians.

1. Park the vehicle on a level surface and block or chock the wheels. Release the parking brakes and build the air system to governor cut-out.

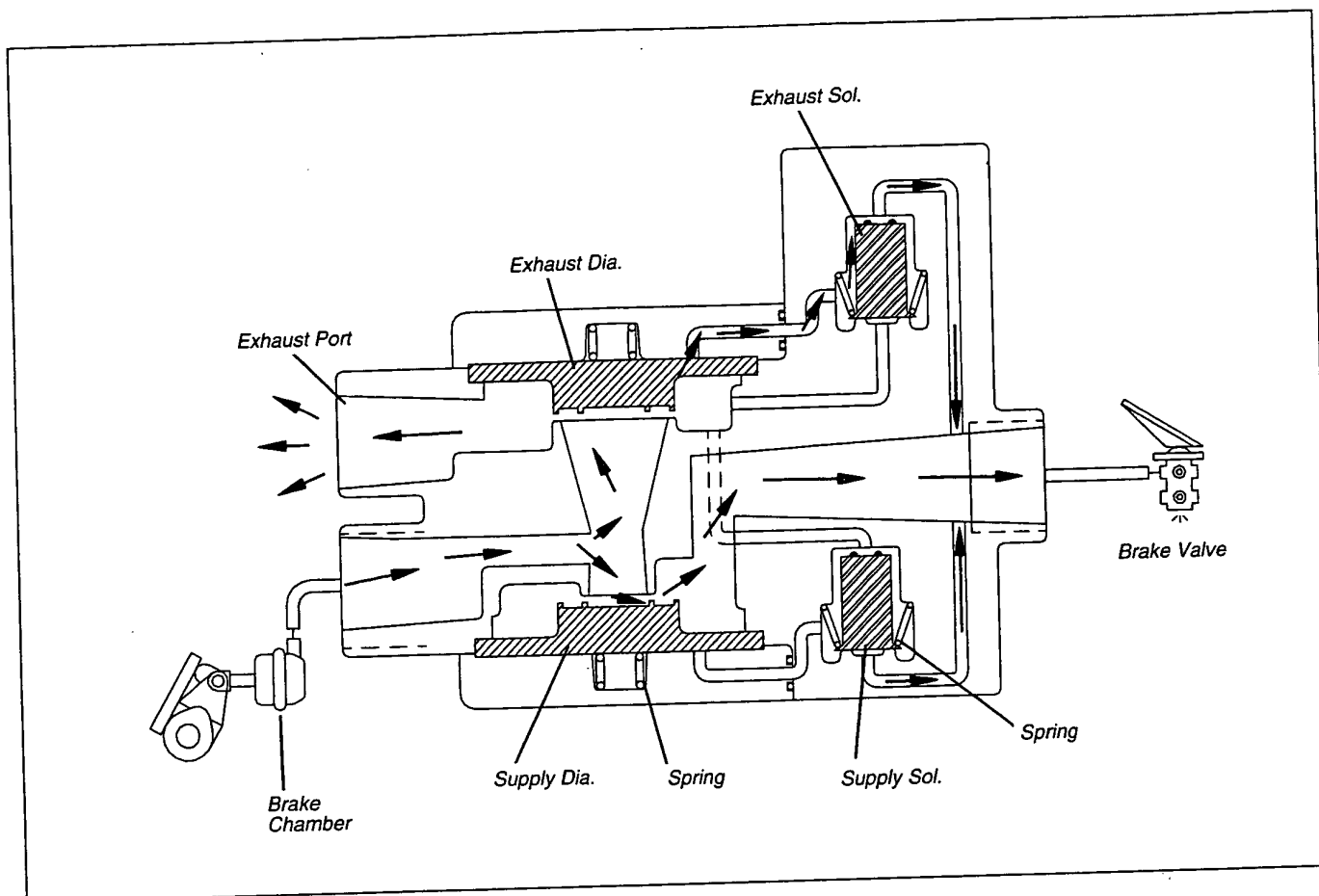


FIGURE 6 M-21, M-22 NON-ANTILOCK EXHAUST (RAPID)

2. Turn the engine ignition key to the OFF position then make and hold a full brake application.
3. With the brake application held and a service technicians posted at one of the modulators, turn the vehicle ignition key to the ON position. ONE OR TWO SHORT bursts of air pressure should be noted at the modulator exhaust. Repeat the test for each modulator on the vehicle. If at least a single burst of exhaust is not noted or the exhaust of air is prolonged and not short, sharp and well defined, perform the Electrical Tests.

### ELECTRICAL TESTS

1. Before testing the solenoid assembly of a "suspect" modulator, its location on the vehicle should be confirmed using the Trouble Shooting or Start-Up procedure for the specific antilock controller in use. (See the Service Data Sheet for the antilock controller for this procedure.)
2. Proceed to the modulator in question and inspect its wiring connector. Disconnect the connector and test the resistance between the pins ON THE MODULATOR. Refer to figure 9.

A. HOLD to SOURCE: Read 3.5 to 5 OHMS

B. EXHAUST to SOURCE: Read 3.5 to 5 OHMS

C. EXHAUST to HOLD: Read 7 to 10 OHMS

D. Individually test the resistance of each pin to vehicle ground and note there is NO CONTINUITY.

If the resistance readings are as shown, the wire harness leading to the modulator may require repair or replacement. Before attempting repair or replacement of the wire harness, refer to the test procedures specified for the antilock controller in use for possible further testing that may be required to substantiate the wire harness problem. If the resistance values are NOT AS SHOWN ABOVE, replace the modulator.

### VALVE REMOVAL

1. Park the vehicle on a level surface and block the wheels and/or hold the vehicle by means other than the air brakes.
2. Drain the air pressure from all vehicle reservoirs.
3. Identify and mark or label all air lines and their respective connections on the valve to facilitate ease of installation.
4. Disconnect both air lines and the electrical connector.

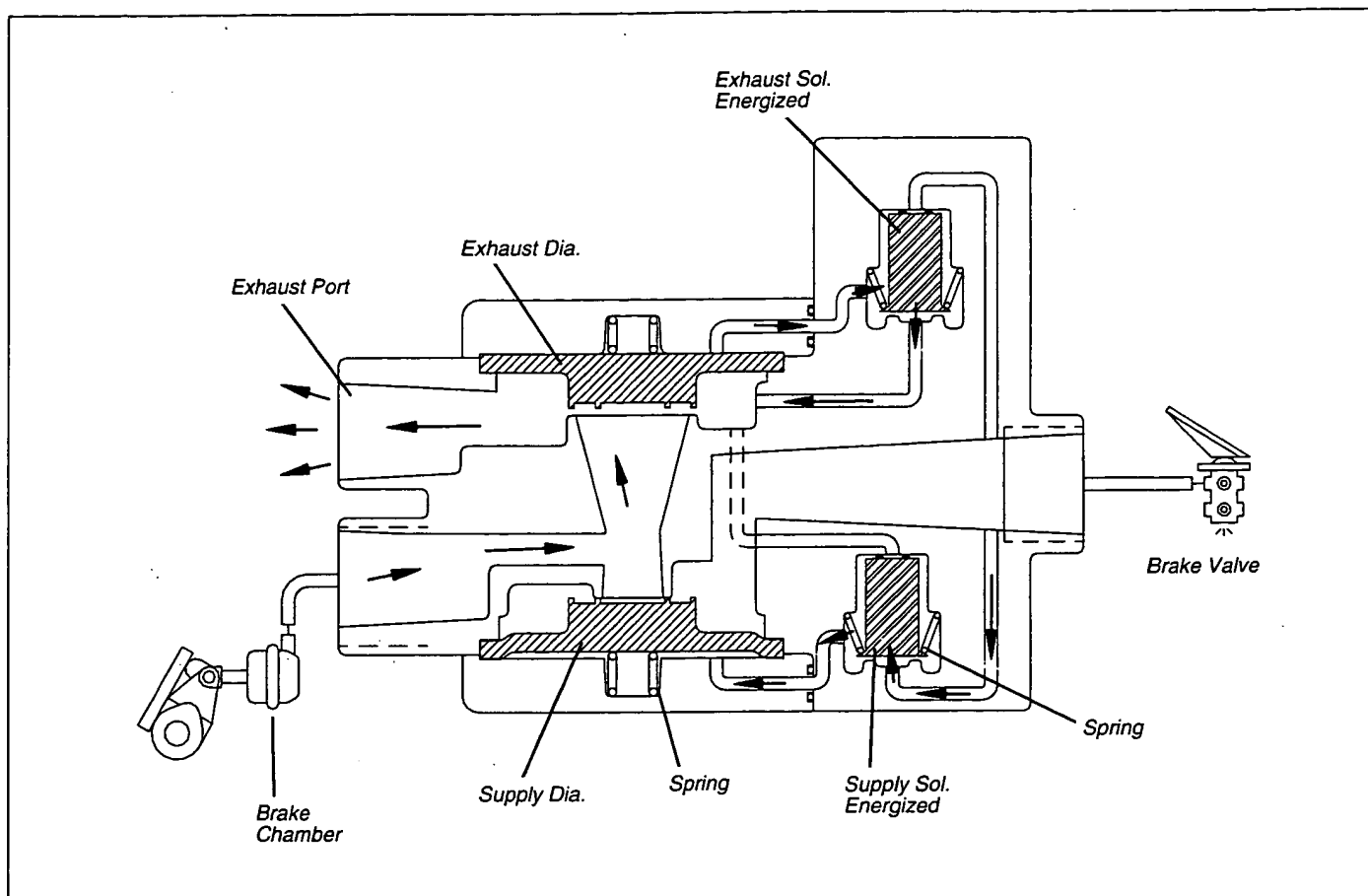


FIGURE 7 M-21,M-22 ANTILOCK EXHAUST

5. Remove the valve from the vehicle.

## VALVE INSTALLATION

1. Install all air line fittings and plugs making certain thread sealing material does not enter the valve.
2. Install the assembled valve on the vehicle.
3. Reconnect both air lines to the valve using the identification made during VALVE REMOVAL step 3.
4. Reconnect the electrical connector to the modulator.
5. After installing the valve, test all air fittings for excessive leakage and tighten as needed.

## M-21 TECHNICAL INFORMATION

Porting -	1 Supply Port (from brake, relay or quick release valve) 1 Delivery Port (brake actuator)
Solenoid Voltage -	12 Volts DC Nominal
Maximum Operating Pressure -	150 psi Gauge
Operating Temp. Range -	-40 to +185 Fahrenheit
Pressure Differential -	1 psi maximum



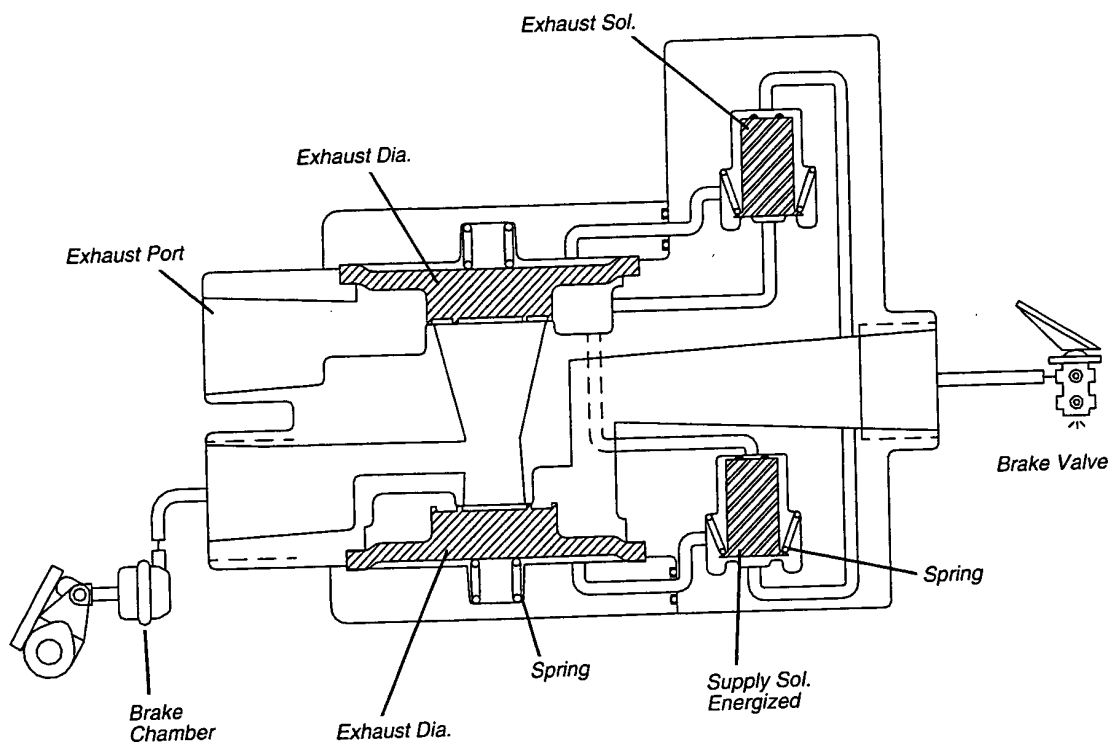


FIGURE 8 M-21,M-22 ANTILOCK HOLDING POSITION

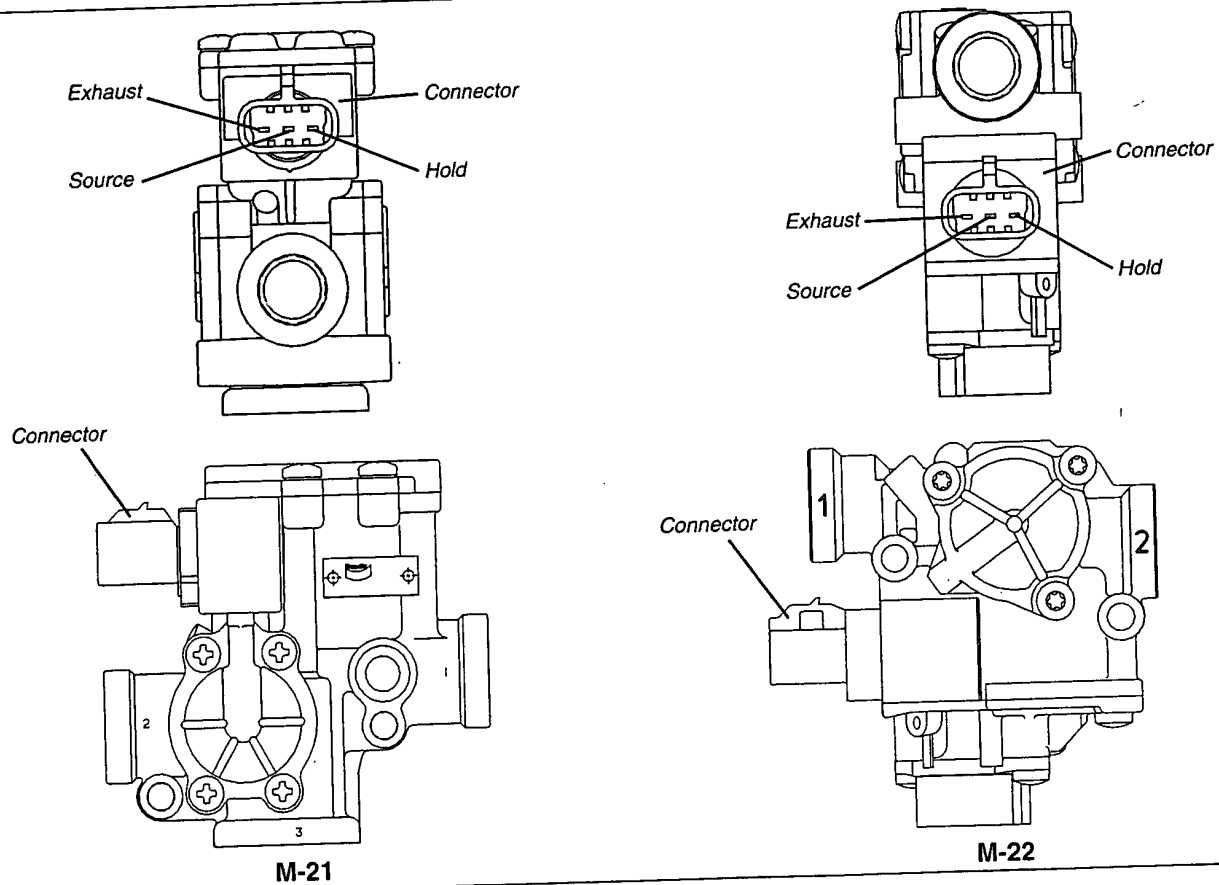


FIGURE 9 M-21,M-22 CONNECTOR